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WAVELET FEATURE EXTRACTION BASED HUMAN IRIS RECOGNITION

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ABSTRACT

Personal identification has become the most important factor in authentication processes in recent years. The various biometric identifiers such as face, iris, fingerprint, hand, voice, signature recognition are used for human identification. Among all these biometric identifiers, Iris recognition is the most reliable and accurate biometric identifier as iris cannot be forged. This paper project involves the acquisition of the image of an eye followed by the segmentation and localization of the image to obtain the image of iris. The Haar wavelet is used for feature extraction of an image. Hamming distance is measured between the image in the database and the detected image. Iris recognition is then performed by matching the iris pair with the minimum Hamming distance.

Keywords: personal identification, iris recognition, haar wavelet, hamming distance.

1. INTRODUCTION

Biometrics refers to metrics related to human characteristics. Biometric authentication is a form of identification and access control. It is also used to identify individuals in groups that are under surveillance. Biometrics is used for automatic human authentication based on unique physiological and behavioral characteristics. Biometric identifiers are the distinctive, measurable characteristics used to describe individuals. The selection of a particular biometric for use in a specific application involves a weighting of several factors. The selection of proper biometric identifier is based on application. Certain biometrics will be better than others based on the required levels of convenience and security. No single biometric will meet all the requirements of every possible application. When thieves cannot get access to secure properties, there is a chance that the thieves will stalk and assault the property owner to gain access. If the item is secured with a biometric device, the damage to the owner could be irreversible, and potentially cost more than the secured property. Among all the biometric identifiers such as face, iris, fingerprint, hand, voice, signature recognition, iris recognition is highly reliable and is used for personal identification. Furthermore, iris recognition systems can be non-invasive to their users [1] [2]. Iris is a part of an eye. The iris is a thin, circular structure in the eye. It controls the diameter and size of the pupils.

Iris recognition is the most accurate biometric identifier available in today's world. The iris, being found to be very stable, highly unique and easy to capture, is classified as one of the better biometric identifiers [3] [4]. Its is a process that analyses the features such as rings, furrows, and freckles that exist in the coloured tissue surrounding the pupil [5]. The human eye images are acquired from a UBIRIS database [6]. Later, segmentation is performed on the acquired image to exactly locate the iris in the entire image of the eye. The Haar wavelet transformation technique is applied on the segmented image to extract the features from the iris image [7]. The feature extraction involves the conversion of the detected image into binary form. Each iris in the database has different binary pattern. A threshold hamming distance is decided based on the images available in the database and the similarity between the detected and the reference image in the database is measured, thus enabling the determination of accuracy of the iris recognition system. An iris recognition system uses the iris to distinguish the identity of a person using the rich iris texture feature [8]. The iris has a unique pattern and texture in the human eye and cannot be transferred or faked which makes the iris more secure than other biometric systems [9]. The success of iris recognition depends mainly on image acquisition and the iris recognition algorithm [10]. Figure.1 shows the structure of the human eye and their other parts such as pupil, sclera and eyelids are present along with the iris.

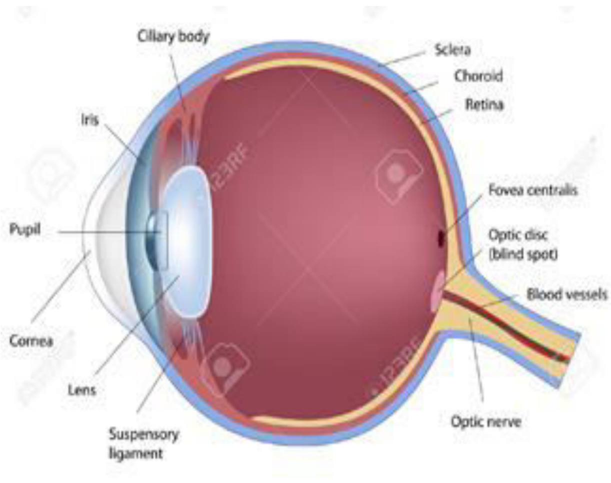

Figure-1. Structure of human eye.

Irises have approximately 266 distinctive characteristics, of which approximately 173 are used to create the iris template [11]. The iris is a thin, circular structure in the eye, responsible for controlling the diameter and size of the pupil and thus the amount of light reaching the retina [12]. Eye colour is defined by that of

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the iris. In optical terms, pupil is the eye's aperture, while iris is the diaphragm that serves as the aperture stop. The iris consists of two layers: the front pigmented fibro vascular known as a stroma and, beneath the stroma, pigmented epithelial cells. The iris along with the anterior ciliary body provide a secondary pathway for aqueous humour to drain from the eye. The iris is divided into two major regions: The pupillary zone is the inner region whose edge forms the boundary of the pupil; the ciliary zone is the rest of the iris that extends to its origin at the ciliary body. The collarette is the thickest region of the iris, separating the pupillary portion from the ciliary portion. The collarette is a rudiment of the coating of the embryonic pupil. It is typically defined as the region where the sphincter muscle and dilator muscle overlap. Radial ridges extend from the periphery to the pupillary zone, to supply the iris with blood vessels. The root of the iris is the thinnest and most peripheral. The muscle cells of the iris are smooth muscle in mammals and amphibians, but are striated muscle in reptiles (including birds). Many fish have neither, and, as a result, their irises are unable to dilate and contract, so that the pupil always remains of a fixed size.

2. RESEARCH METHOD

The proposed iris recognition system consists of four steps i.e. Image acquisition, Segmentation, Feature Extraction, Matching.

2.1 Image acquisition

The first stage of iris recognition system is to acquire an image called image acquisition. The iris images are acquired from UBIRIS database.

2.2 Image segmentation

The image segmentation step is used to convert the acquired image into gray scale image. In a grayscale image, each pixel indicates gray scale intensity which may vary from 0 to 255. The purpose of image segmentation is to cluster pixels of an image into image regions [13]. Iris lies between sclera and pupil. The segmentation step separates the iris from the eye image. The canny edge detector is used for locating the inner and outer boundaries of iris. Edge detection is used to detect the boundaries of the iris and the pupil.

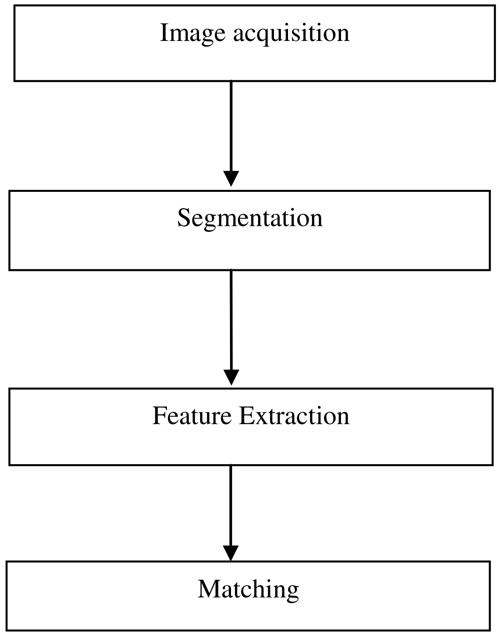


Figure-2. Block diagram of iris recognition system.

2.2.1 Hough transform

The Hough transform is a technique which can be used to isolate features of a particular shape within an image. Because it requires that the desired features be specified in some parametric form, the classical hough transform is most commonly used for the detection of regular curves such as lines, circles, ellipses, etc. The Hough transform is used to obtain successful localization boundary and to find circles in the edge image [14] [15]. The every edge pixel has different radii. The Hough transform is used to calculate the outer boundary of the iris and to calculate the pupil boundary. This edge detector act as a circular edge detector by finding the gradient image along the boundary of circle of increasing radii. The maximum sum of all the circles is used to find the circle center and radii. The classical Hough transform was concerned with the identification of lines in the image, but later the Hough transform has been extended to identifying positions of arbitrary shapes, most commonly circles or ellipses.

2.2.2 Circular hough transform

The circular Hough Transform (CHT) is used for detecting circles. It is a specialized Hough Transform. The purpose of the technique is to find circles in imperfect image inputs [16]. The circle candidates are produced by “voting” in the Hough parameter space and then select the local maxima in a so-called accumulator matrix. An accumulator matrix is introduced to find the intersection point in the parameter space. First, we need to divide the parameter space into “buckets” using a grid and produce an accumulator matrix according to the grid. The element in the accumulator matrix denotes the number of “circles” in the parameter space that passing through the corresponding grid cell in the parameter space. The number is also called “voting number”. Initially, every element in the matrix is zeros. Then for each “edge” point in the original space, we can formulate a circle in the parameter space and increase the voting number of the grid cell which the circle passing through. This process is called "voting". After voting, we can find local maxima in the accumulator matrix. The positions of the local maxima are corresponding to the circle centers in the original space.

2.3 Feature extraction

The iris pattern in a iris image was represented by a group of feature vectors for matching. This representation was constructed by calculating a set of feature values to form a feature vector, which was achieved by using a haar wavelet. Transforming the input data into the set of features is called feature extraction [17]. The haar wavelet is used to extract feature form the iris region. The main aim of feature extraction is used to convert image into the binary form. Haar wavelet creates very simple wave forms [18] [19]. Wavelet function is always equal to the window function therefore; It provides both time and frequency analysis of signal simultaneously [20] [21]. Wavelet transforms have advantages over traditional Fourier transforms for representing functions that have discontinuities and sharp peaks, and for accurately deconstructing and reconstructing finite, non-periodic, and/or non-stationary signals [22] [23]. In the case of the discrete wavelet transform, the choice of the scale is performed by multiple signal passage through the wavelet filter [24]. The input image is decomposed into various sub bands using discrete wavelet transform [25]. The wavelet transform coefficient can reflect the signal or function. Then accuracy is to be improved. The most important step in automatic iris recognition is the ability of extracting some unique attributes from iris, which help to generate a specific code for each individual.

2.4 Matching

Matching is the final step of iris recognition. It matches the image with the database image or stored image. UBIRIS.v1 database is used for this iris recognition system. It contains the 765 gray scale images with 108 unique eye and five different images of each unique eye. The Hamming distance is the matching metric employed by Daugman, and calculation of the Hamming distance is taken only in bits that are generated from the actual iris region [26]. It measures the minimum number of substitutions required to change one string into the other, or the minimum number of errors that could have transformed one string into the other [27]. The equation 1 shows the Hamming distance (HD).

$$HD=\frac{1}{N}\sum_{k=1}^{N} X_k EXOR \ Y_k \qquad (1)$$

Wherek and Y_k are the two bit wise template to compare and N is the number of bits represented by each templates and N is the number of bits in the feature vector, X_J is the feature of the tested iris, and Y_J is the feature of the iris template. EX OR Indicates the Exclusive OR operation. If two bit patterns are completely independent, such as iris templates generated from different irises, the Hamming distance the two patterns will be equal to one. If two patterns are derived from the same iris, the Hamming distance between them will be less than one, since they are highly correlated and the bits should agree between the two iris codes. Thus, when comparing two iris images, their corresponding binary feature vectors are passed to a function responsible of calculating the Hamming distance between the two. The decision of whether these two images belong to the same person depends upon the following result:

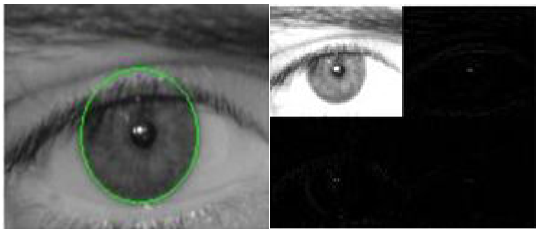
If HD< 1, then the two images belongs to the same person.

If HD = 1, then the two images does not match, it means the iris image belongs to unauthorized person.

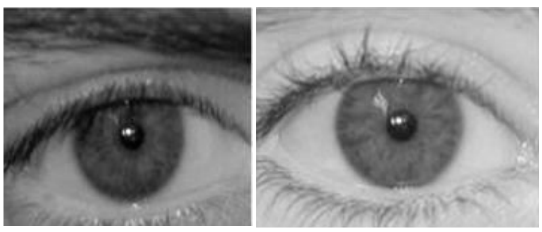
3. RESULTS AND ANALYSIS

The eye images are acquired from UBIRIS database. This is the first stage of iris recognition. The canny edge detection is used to detect the edges of an image. Then circular Hough transform is used for detecting the circle. The haar wavelet extracts the features of an image by using wavelet decomposition Finally the irises are recognized with the help of hamming distance The Figure-3 shows the results of wavelet based Iris recognition system.

(a) Input image (b) edge detected image



(c) Segmentation of image (d) wavelet transform image



e) Reconstructed Iris image f) Comparison image1

Figure-3. Results of wavelet based iris recognition system.

It was observed that the input image and comparison image 1 do not match as the Hamming

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distance between the input image and comparison image 2 is equal to one.

The Table-1 shows the results of iris recognition. The Iris images are taken from the UBIRIS database. It was observed that the input image and comparison image will be matched if the hamming distance is less than one. The input image and comparison image will not be matched if the hamming distance is less than one.

4. CONCLUSIONS

In this paper, the human iris images are recognized using haar wavelet based feature extraction. The iris recognition is the reliable biometrics out of all the available biometrics such as facial, iris, fingerprint, hand, voice, signature recognition. The canny edge detection and circular hough transform is used for segmentation of Iris image The haar wavelet transform is used for the feature extraction. The irises are recognized by calculating the Hamming distance to check the input imagewith the database images. The proposed wavelet feature extraction based human iris recognition system is highly reliable and more efficient. This research work can be further extended by applying various wavelets for feature extraction and various matching techniques for iris recognition.

Table-1. Results of iris image recognition.

S. No	Input image	Comparison image 1	Hamming distance	Inference	Comparison image 2	Hamming distance	Inference
1			=1	Images do not match		<1	Images match
2			<1	Images match		=1	Images do not match
3			<1	Images match		=1	Images do not match
4			<1	Images match		=1	Images do not match

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